THURSDAY, JULY 23, 1891.

THE TEACHING OF FORESTRY.[1]

A Manual of Forestry. By William Schlich, C.I.E., Ph.D. Vol. II. (London: Bradbury, Agnew, and Co., 1889.)

IN a loop of the Main river in Lower Franconia, east of Aschaffenburg, rises an extensive mountainous country, clothed with almost unbroken forest of singular beauty and of enormous value. It is the Spessart, in old times known as the home and haunt of great highway robbers, but also known from time immemorial as the home of the best oak timber in Germany. The red sandstone of the Trias, which everywhere is the underlying rock in this extensive forest country, makes a light sandy loam, which, where deep, is capable of producing tall, cylindrical, well-shaped stems. Having grown up, while young, in a densely crowded wood, the oak here has cleared itself of side branches at an early age. Hence these clean straight stems, which in the case of spruce, silver fir, and other forest trees, may justly be said to be the rule, but which the oak does not produce, save under these and similarly favourable circumstances. The species here is *Quercus sessiliflora*: this species does not form pure forests, but is always found mixed with other trees, the hornbeam, the beech, and on the lower slopes of the western Schwarzwald, the silver fir. In the Spessart, the beech is associated with the oak, in the same manner as the bamboo is the chief associate of the teak tree in Burma.

In publishing his manual of forestry, the author wished in the first instance to place in the hands of the students at the Coopers Hill Forest School a handbook to facilitate their studies. That Forest School was, it may be remembered, established in 1885, in connection with the Royal Indian Engineering College at the same place, in order to give the needful professional training to young Englishmen who desired to enter the Indian Forest Department. Accordingly, when the first volume of that manual appeared in 1889, it was natural that some, who took a strong interest in the progress of forest management in the British Indian Empire, were surprised that the book did not deal with Indian trees, and that its teaching related to the oak, the beech, the Scotch pine, and other trees of Europe. By some of these zealous friends of Indian forestry the book was pronounced a failure, because it did not treat of Indian forest trees.

The principles which guide the forester in the proper treatment of his woods are the same all over the world, in India as well as in Europe. But while the application of these principles to the treatment of Indian forests is not more than thirty-five years old, the methodical and systematic treatment of European forests is of old standing, and has stood the test of experience. In the teak forests of Burma, the bamboo has a position similar to that of the beech in the oak forests of the Spessart. Oak and teak are both trees with comparatively light foliage. Pure woods of these species, while young, are sufficiently dense to shade the ground, whereas at an advanced age the wood gets thin, the canopy light, and the result is that grass and weeds appear, and that by the action of sun and wind the soil hardens and is less fertile than the loose porous soil, which is shaded by dense masses of foliage. Hence the advantage of associates, which, like the beech in Europe and the bamboo in Burma, shade the ground with their dense foliage and enrich it by the abundant fall of their leaves. But it is not only the condition of the ground which is improved by these useful associates. Teak and oak have this specialty also in common, that, when growing up alone, their stems, instead of running up into clean cylindrical boles, are apt to throw out side branches, which greatly impair the market value of the log. But when growing up in dense masses with their natural associates, these latter, crowding in as they do on all sides, around the oak in the Spessart and the teak in Burma, prevent the development of side branches and thus produce clean and regularly shaped stems.

In these and many other ways are the associates of the teak and of the oak useful friends, so to speak. Under certain circumstances, however, and at certain periods of their life, they are dangerous enemies to their more valuable companions. On the sandstone of the Spessart and elsewhere, the beech, as a rule, has a more vigorous growth than the oak; it gets the upper hand, and, unless it is cut back or thinned out in time, the oak, if both are growing up in an even mixture, has no chance. The bamboo is even more formidable as an enemy of the young teak tree. Though the teak may have had a long start; if a crop of bamboos—either the shoots of old rhizomes, or perhaps the result of general seeding of the old bamboo forest, cleared away to make room for the teak—springs up among it, the teak is doomed. As soon as the rhizomes of the bamboo have acquired sufficient strength, they produce, within a few weeks, during the rains, such a profusion of full-sized shoots, say 20 to 30 feet high, that the young teak trees among them are throttled and extinguished.

The similarity in the relations of teak and bamboo in Burma, and of oak and beech in the Spessart, has led foresters in both countries to devise similar arrangements for the regeneration of these forests. In the Spessart, when the old timber in a compartment of the forest is cut, the best places for the growth of the oak are selected, and the oak, which here sells at the rate of from 2*s*. to 3*s*. a cubic foot for sound and well-shaped pieces, is sown on soil most suitable for its development; while the beech, the timber of which only fetches about one-fifth of that amount, is allowed to reproduce naturally from self-sown seedlings over the rest of the area. Among the oak also a certain but small proportion of beech springs up, and even where pure oak woods may be the result of these proceedings, it will not be difficult, when they are sufficiently advanced, to introduce such a proportion of beech as will secure their satisfactory development. In the same way in Burma, selected areas are cleared for the growth of teak in the original forest, the clearance being effected and the teak planted with the aid of that rude mode of shifting cultivation, known as the Toungya system.

Many other instances might be quoted, in which similar practices have developed in the rearing and tending of woods in Europe and in India. The principles of sylviculture are the same everywhere, and the application of these principles to the treatment of woods in different parts of the globe has, in many instances, led to the adoption of similar methods; hence Dr. Schlich was right in selecting the timber trees of Europe to illustrate the application of these principles in the manual before us.

---

[1] See NATURE, vol. xli. p. 121.

Sylviculture, the author explains, is the formation and tending of woods, and he divides his subject into four chapters. The first of these chapters treats of preliminary works, such as choice of species, fencing and reclamation of the soil by draining, the fixation of shifting sands, the breaking through of an impermeable substratum (pan) and the like. In regard to the fixation of shifting sands, an interesting account is given on p. 33 of the methods which have been most successfully practised on the west coast of France, in order to stop the progress inland of the coast dunes, and to clothe these ridges of rolling sand with a productive forest of the cluster pine (*Pinus Pinaster*). A belt, in many places five miles wide, along the coast of Gascony, and considerably further north, has in this manner been reclaimed, and the steady progress of the sand, which had covered large areas of fields and meadows, and which had destroyed numerous villages, has thus been arrested.

Chapter ii. deals with the formation of woods by artificial and natural means. The Spessart, which has been mentioned above, is an instance in which both artificial and natural means are used in order to effect the regeneration of the forest, so as to insure the production of timber of the highest possible commercial value. In most large forest districts on the continent of Europe, both the natural and artificial method are employed. As the author says on p. 178, neither the one nor the other system "is the best at all times and under any circumstances; only a consideration of the local conditions can lead to a sound decision as to which is preferable in a given case." In France, for instance, a country highly favoured by a climate uniformly moist and mild, where most forest trees produce seed more frequently than in Germany, natural reproduction may, broadly speaking, be said to be the rule and planting the exception. But in France, also, planting operations on a large scale have been carried out on the dunes of the west coast as well as on bare mountain-sides of the Alps, the Cevennes, and the Pyrenees, and, wherever necessary, planting is resorted to, to supplement the natural regeneration of the forests.

An instance in which over a large extent of country the forests are regenerated artificially may be found in the State forests of the kingdom of Saxony, together with most of the communal and many of the private forests in that country. The State forests of Saxony cover an area of 432,000 acres, and by far the larger portion of this area is stocked with pure spruce forest treated on a short rotation of eighty years, and regenerated artificially by planting. The high prices realized in this industrious and thickly populated country, even for timber of small sizes, have gradually led to the adoption of this system; and the State forests of the kingdom of Saxony are a pattern of methodical and most successful management. The forest ranges, all in charge of highly trained superior forest officers, are small, containing not more than 2000 to 3000 acres each, and many of these ranges have a steady regular annual yield of 140 cubic feet of timber per acre, and furnish a net revenue, after deducting all charges, general and local, of 100 marks per hectare, which corresponds to forty shillings an acre.

But in Great Britain also, and in Scotland especially, is the system of rearing forests by planting well understood, and it is practised over large areas economically and successfully. French as well as German foresters of great practical experience have repeatedly expressed their high sense of the skill and ability with which large plantations are formed in Great Britain at a comparatively moderate cost. But even foresters and wood-managers in Great Britain may learn a good deal from this portion of Dr. Schlich's book. Their attention might specially be directed to the author's remarks on p. 113, regarding transplants which have developed a lopsided root system, "because the trenches, into which the pricked out seedlings are placed, are often made so shallow, that the root system of the plants, instead of assuming a natural position in the ground, is altogether bent to one side."

That section of the second chapter which deals with the natural regeneration of woods, necessarily divides itself into two portions: first, natural regeneration by seed; and second, by shoots and suckers (pollards and coppice). Concise brevity is one of the great merits of Dr. Schlich's manual, and it doubtless was necessary to curtail, and to make a rigid selection of the most important matters. But the treatment of coppice woods and of coppice under standards might perhaps have been a little less brief.

As regards natural regeneration by seed, the Black Forest in South-Western Germany may be quoted as an instance where, over extensive areas, the forest is chiefly regenerated by natural means. The splendid logs of spruce and silver fir, which are floated down the Rhine in numberless huge rafts, have all grown from self-sown seedlings, and most of the young timber now growing up has had the same origin. The timber which is brought to market from these forests is much older and heavier than that sold in the forests of Saxony, but the results of management are to some extent similar. There are some forest ranges in the Schwarzwald, both in the grand-duchy of Baden and in the kingdom of Württemberg, which yield the same annual quantity of timber per acre, and furnish the same rate of net revenue to their proprietors, as those of Saxony. The term of rotation, of course, is much longer, and the system of natural reproduction takes time, hence the money value of the growing stock of old timber is very large, much larger per acre than in Saxony. The interest, therefore, on the capital invested (value of land plus growing crop) is less in this case. The discussion of these matters, however, does not appertain to sylviculture, but to forest management, with which the author will deal in a subsequent volume of his work.

As already mentioned, in France the natural regeneration of forests is the rule, chiefly owing to its wonderfully favourable climate. Large areas, mainly of private and communal forest, are managed in admirable style, as coppice woods and as coppice under standards. The treatment of high timber forests also, and their regeneration from self-sown seedlings, by means of a regular system of successive cuttings, has in France been brought to a high state of perfection. This circumstance renders the French forests specially valuable as a field of instruction for foresters proceeding to India. For in that large country, though planting has been commenced and must necessarily be carried on in some instances on a large scale, yet every effort ought to be made to develop good systems of natural regeneration in the different provinces.

On pp. 132–64 the author gives a clear account of the different systems which have in course of time been devised, in order to effect the natural regeneration of woods by seed. Under the more favourable climate of France the desired object is generally effected by a simple and to some extent uniform system of successive cuttings. In Germany, on the other hand, where droughts are frequent, frosts severe, and where good seed years generally are of rare occurrence, the system of regular successive cuttings, which originated in Germany, in many cases was found to fail, and accordingly, some sixty or seventy years ago, the tide set in in favour of artificial reproduction. A reaction, however, has for good reasons taken place in many parts of the country, and during the last thirty years German foresters have been busy in adapting the system of natural regeneration to the peculiar conditions of each forest district. Indian forest students should go to France, in order to become impressed with the fact that under favourable circumstances natural regeneration of high forests may be effected by a simple and easy system of treatment. In German forests, on the other hand, they should learn how the difficulties of a climate frequently unfavourable have been successfully overcome by devising systems of treatment suitable to the requirements of each locality, and the knowledge here acquired will be most useful, nay, necessary, to them in India, where the conditions of climate by no means always favour the natural regeneration of the more valuable forest trees.

Space forbids a full discussion of this most important and interesting subject. This portion of Dr. Schlich's book, if supplemented by the study of forests on a large scale, particularly in Germany, will be most useful to foresters who may be called upon to devise methods of forest treatment in other parts of the globe, be it India, Australia, South Africa, or North America.

Closely allied to the subject just adverted to is what the author says in the fourth section of the same chapter regarding the formation of mixed woods. Pure woods, consisting of one species only, are exposed to various risks, from which mixed woods are exempt. Hence, in most Continental forests, there has of late years been a strong tendency in the direction of favouring the growth of mixed woods, such as oak and beech, oak and hornbeam, oak and silver fir, Scotch pine and beech, and the like. It goes without saying, that operations in this direction, in order to be successful, must be guided by careful study of the mode of growth and of the peculiar requirements of the different species in different places and under different conditions. Something has been said above regarding the treatment of mixed woods of oak and beech in the Spessart. But it does not follow that oak and beech behave in the same manner everywhere. On certain kinds of shale, belonging to the Devonian formation, for instance, the oak rather than the beech has the tendency to take the lead, and here mixed woods of oak and beech can be produced from self-sown seedlings much more easily than would be possible on the sandstone of the Spessart. Again, along the foot of the Western Schwarzwald, where, as already stated, the silver fir is associated with the oak, this tree, though a shade-bearer like the beech, renders it much easier for the oak to hold its own in an even-aged mixed wood, because in its early youth it grows very slowly, thus giving the oak a good start in life.

Chapter iii. teaches how woods should be tended during early youth and afterwards. Passing over what the author says regarding cleaning of young woods and pruning, we come to thinning operations. On p. 209 an interesting statement is given showing the number of trees per acre in certain mixed woods of the Schwarzwald. The figures are as follows :—

Age of wood in years.	Number of trees per acre.
20	3960
40	1013
60	449
80	346
100	262

Thus, during the life of a wood, and this holds good in all cases, the number of trees per acre decreases gradually from several thousand to a comparatively small number at maturity. When, as usual, the object is to produce high class timber, with clean well-shapen stems, the rule is, as the author correctly states it: "The wood should be thinned lightly until towards the end of the principal height growth; then the thinnings should gradually become heavier, so as to assist a selected number of trees by the gradual removal of all those which are inferior and diseased." In its youth the wood is crowded, the young trees maintaining a severe struggle for existence. The weaker trees are suppressed and some are actually killed, while the rest are either dominant trees, with their head well above the others, or dominated, though not suppressed. Formerly thinnings were generally done by rule of thumb, the dead, oppressed, and a portion of the dominated trees being removed. But it is obvious that, when the object is to produce valuable timber, thinnings must so be managed, that the trees which are destined to attain the term of rotation, and which will form the final crop to be cut down, in the example here given, 262 trees per acre 100 years old, shall be sound and regularly shaped. It is obvious that to attain this object dominant trees also may occasionally have to be removed, if unsound, spreading, or irregular shaped, and this is properly recognized by the author. He justly adds that in such cases dominated and even suppressed trees may have to be spared in order to keep the ground well under cover. Such would be the practice in the case of woods consisting of one species only, or of several species of equal value. Where one species, such as oak or teak, is of much greater value than the others, all thinnings must, as a matter of course, be so arranged as to favour this species at the expense of the rest.

So far concerning the thinning of crowded woods. The last section of the same chapter deals with the tending of open woods for the production of large timber. Into this subject, which is one of some difficulty, though of great importance, it would lead too far to enter on the present occasion.

Chapter iv. contains sylvicultural notes on British forest trees, with notes (by Prof. H. Marshall Ward) on botanical characters serving to distinguish the principal British forest trees. The two species of oak dealt with in the sylvicultural notes are *Quercus pedunculata* and *Quercus sessiliflora*. Botanists are well aware that the maintenance of distinctive characters between these two and others of the European species of *Quercus* is difficult; so much so, that the best authorities on English trees have decided to re-establish the old species of Linnæus, *Quercus Robur*, and to regard the two species named merely as forms or varieties. The forester has a different task, and for him the mode of growth and the requirements of these two oaks are so different that he must keep them separate. It will suffice to mention one point, which has not perhaps been brought out sufficiently by the author. The mixed woods in which *Quercus sessiliflora* is associated with the beech, the hornbeam, and the silver fir have been mentioned above. In natural high forests this species is only found in company with other trees, and particularly with the three kinds named. The pure or nearly pure coppice woods of *Quercus sessiliflora* in France and Western Germany are an exception; these, however, have been converted into pure woods by the long-continued cutting out of beech, hornbeam, and soft woods. *Quercus pedunculata*, on the other hand, *does* form pure high timber forests of considerable extent. Such are found both in Northern and Southern Europe, not on hilly ground, but always on deep alluvial soil. Instances are the forests on low ground along the Elbe and other rivers of North Germany, the magnificent pure forests of that tree on the banks of the Adour river near Dax in Gascony, and similar ones in the peninsula of Istria, south of Trieste. There is underwood on the ground in the forests named, but it merely consists of thorns and low shrubs. The two species, *Quercus sessiliflora* and *pedunculata* have different requirements and require somewhat different treatment. This, however, is a small matter. These sylvicultural notes are most valuable, and it is satisfactory that the Weymouth pine and the Douglas fir have been included among them.

The second volume of Dr. Schlich's manual, like the first, will be an immense help to the students who are trained at the Coopers Hill College for forest service in India. It will be a great boon to all who are charged with the management of forests in India, in the colonies, and in the United States of North America. And it may perhaps be hoped that in Great Britain also this excellent book will in course of time tend to awaken a more general interest in the good management of its woodlands, which are very extensive, and which some day may be of considerable importance and of great value to their proprietors. D. BRANDIS.

THE APPLICATIONS OF MODERN CHEMISTRY.

Dictionary of Applied Chemistry. Vol. II. (Eau–Nux). (London: Longmans, 1891.)

THE editor of a dictionary of applied science, such as the volume before me, has in these days no enviable task to perform: much is required of him, and the difficulties with which he has to contend are great. Prof. Thorpe has acquitted himself well, for though there may be, indeed there are, many points with which the expert can find fault, yet these are generally matters of detail, and on the whole the work has been satisfactorily done, so that the second volume will be found to be quite up to the high level of the first. The industries which owe their foundation to the science of chemistry now progress with such giant strides, that processes which last year were the newest and best may this year be so improved as to be rendered obsolete, so that an article printed at the commencement of a volume may become antiquated before the last article is in type, whilst data unattainable when the article was written are superseded by some more recently published. As an example of this, I may take that upon "gas coal," written by a most competent authority, Mr. Lewis Wright. On p. 177 will be found a table giving the weight of coal carbonized by all the authorized gas undertakings in the kingdom, exclusive of those of local authorities, for the year ending March 25, 1886. Since these tables were printed, a Board of Trade return for 1890 has been published. In 1886, 8,378,904 tons of coal were carbonized; in 1890 the figure rose to 9,663,011. In 1886 the mileage of mains was 18,967; in 1890 it had increased to 21,584. These numbers point out the enormous extent of the coal-gas industry in this country, and show clearly that it is not suffering from the competition of electric lighting; indeed, this competition is favourable to the sale of gas, for we see that our streets are now better lighted than formerly, and the consumption of gas in many shops is increased, in order to vie with the splendour of their neighbours' electric light.

As a critic is bound to criticize, I may point out some few faults of commission and omission which have struck me in reading through this generally excellent article.

The important steps which have recently been taken in many large works for charging and drawing the gas retorts by mechanical means are barely referred to. Great economy is doubtless effected where such labour-saving mechanical appliances have been adopted, and a description of these would have been of interest, as the labour agitation in our gas-works has brought engineers face to face with this question. Another point upon which a statement would have been of value is the most improved arrangements of the purifying house, and the methods adopted for charging and discharging the purifiers. That "the whole of the sulphuretted hydrogen, carbonic acid, and carbon disulphide can be easily and economically removed" (p. 200) by a combined system of oxide and lime, and with a proper arrangement of purifiers, is a statement to which many gas engineers will demur. The London companies, especially, who have a legal standard limit for sulphur compounds, find it both difficult and expensive to keep down the impurities to the necessary point. The illustrations given in this article are scarcely worthy of the letter-press. Figs. 22 and 23 do not give an idea of the construction of a modern gas-holder, some of which now have the enormous capacity of ten million cubic feet, and are marvels of engineering skill. A description of the latest improvements would have added interest to the article.